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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

WALID ALI

Atty. Docket

US 010194

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Group Art Unit: 2661

Filed: AUGUST 24, 2001

Title: AN APPARATUS AND METHOD FOR COMBINING RANDOM SET OF VIDEO FEATURES IN A NON-LINEAR SCHEME TO BEST DESCRIBE PERCEPTUAL QUALITY OF VIDEO SEQUENCES USING HEURISTIC SEARCH METHODOLOGY

Commissioner for Patents
Washington, D.C. 20231

LETTER TO OFFICIAL DRAFTSMAN

Sir:

Enclosed are (4) four sheets of formal drawings for filing in the above-identified application.

Respectfully submitted,

By _____
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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited this date with the United States Postal Service as first-class mail in an envelope addressed to:
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On April 23, 2002

By _____

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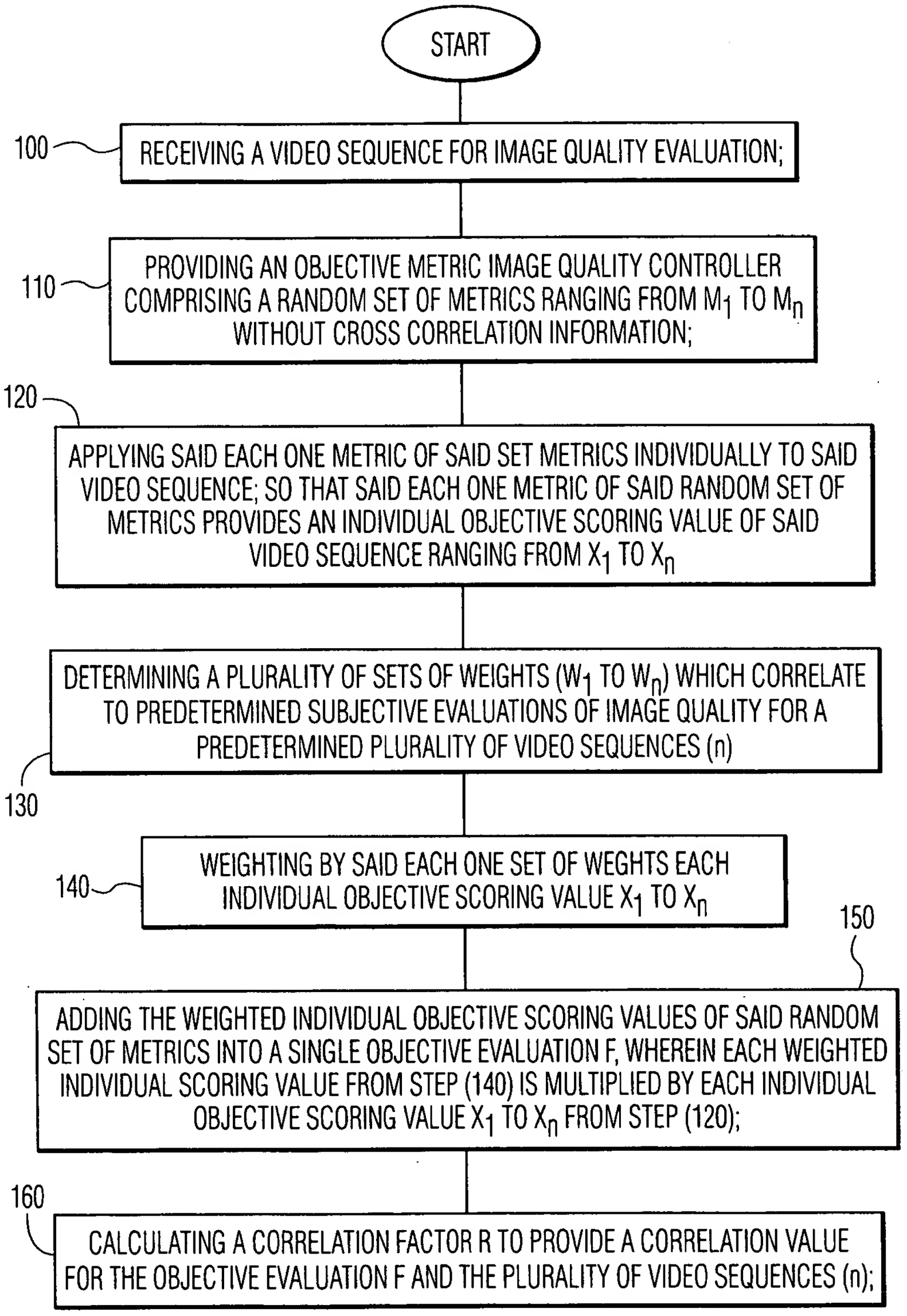
START
100
RECEIVING A VIDEO SEQUENCE FOR IMAGE QUALITY EVALUATION;
110
PROVIDING AN OBJECTIVE METRIC IMAGE QUALITY CONTROLLER COMPRISING A RANDOM SET OF METRICS RANGING FROM M_1 TO M_n WITHOUT CROSS CORRELATION INFORMATION;
120
APPLYING SAID EACH ONE METRIC OF SAID SET METRICS INDIVIDUALLY TO SAID VIDEO SEQUENCE; SO THAT SAID EACH ONE METRIC OF SAID RANDOM SET OF METRICS PROVIDES AN INDIVIDUAL OBJECTIVE SCORING VALUE OF SAID VIDEO SEQUENCE RANGING FROM X_1 TO X_n
130
DETERMINING A PLURALITY OF SETS OF WEIGHTS (W_1 TO W_n) WHICH CORRELATE TO PREDETERMINED SUBJECTIVE EVALUATIONS OF IMAGE QUALITY FOR A PREDETERMINED PLURALITY OF VIDEO SEQUENCES (n)
140
WEIGHTING BY SAID EACH ONE SET OF WEGHTS EACH INDIVIDUAL OBJECTIVE SCORING VALUE X_1 TO X_n
150
ADDING THE WEIGHTED INDIVIDUAL OBJECTIVE SCORING VALUES OF SAID RANDOM SET OF METRICS INTO A SINGLE OBJECTIVE EVALUATION F, WHEREIN EACH WEIGHTED INDIVIDUAL SCORING VALUE FROM STEP (140) IS MULTIPLIED BY EACH INDIVIDUAL OBJECTIVE SCORING VALUE X_1 TO X_n FROM STEP (120);
160
CALCULATING A CORRELATION FACTOR R TO PROVIDE A CORRELATION VALUE FOR THE OBJECTIVE EVALUATION F AND THE PLURALITY OF VIDEO SEQUENCES (n);

FIG. 1A

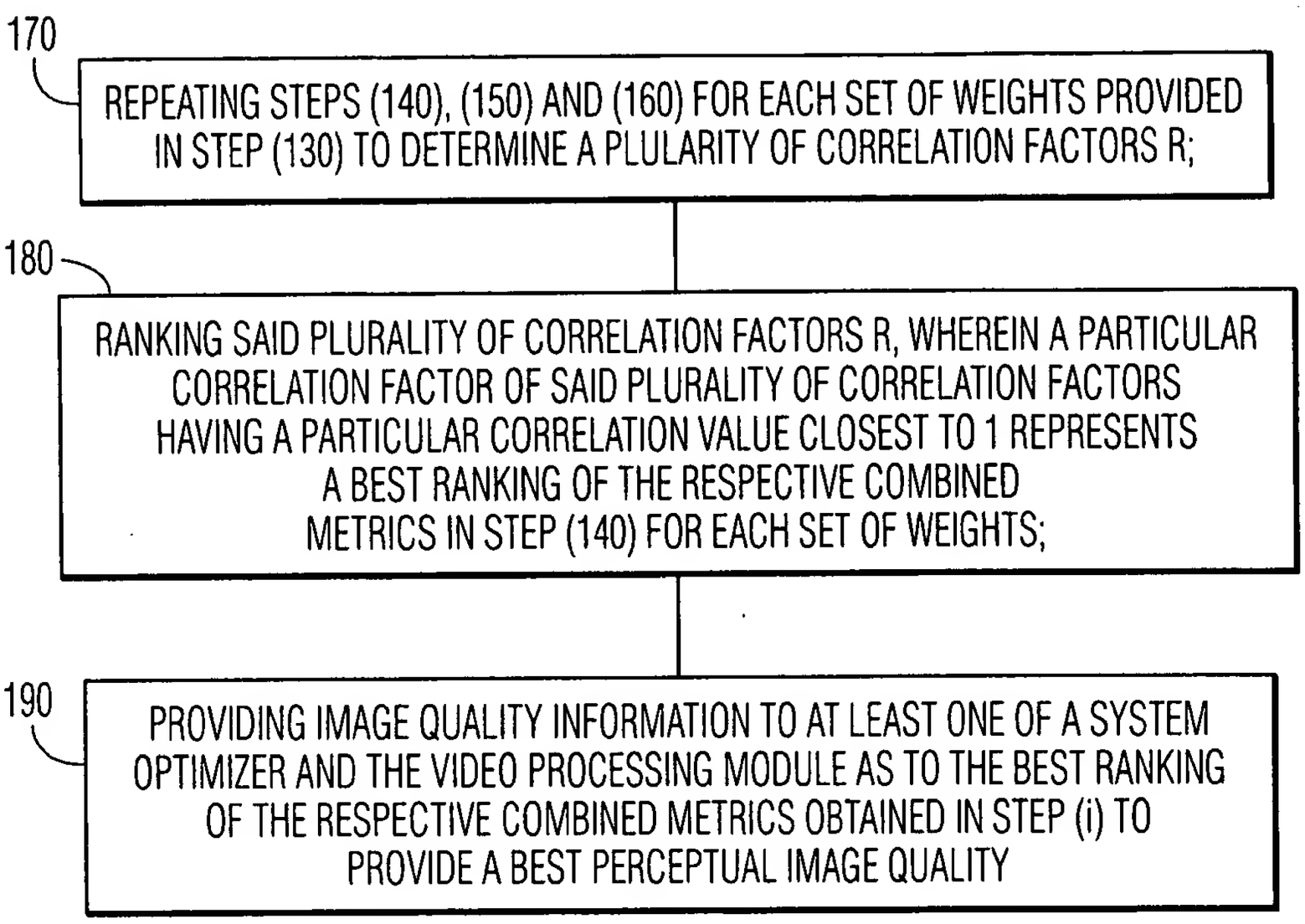

FIG. 1B

WHEN A PREDETERMINED NUMBER OF SETS OF METRICS = n, THE QUADRATIC MODEL TO OBTAIN THE OBJECTIVE EVALUATION F IS:

$$F = \left(\sum_{i=1}^{n} w_i x_i\right)^2$$, WHEREIN "n" IS A NON-ZERO VALUE.

FIG. 1C

WHEN A NUMBER OF THE SET OF METRICS = 4, THEN THE QUADRATIC MODEL TO OBTAIN THE OBJECTIVE EVALUATION F IS:

$$F = w^1x^{1^2} + w^2x^{2^2} + w^3x^{3^2} + w^4x^{4^2} + w^5x^1x^2 + w^6x^1x^3 + w^7x^1x^4 + w^8x^2x^3 + w^9x^2x^4 + w^{10}x^3x^4$$

FIG. 1D

190

SELECTING A BEST OF WEIGHTS FROM THE PLURALITY OF SETS OF WEIGHTS PROVIDED IN STEP (130), SAID BEST SET OF WEIGHTS BEING HEURISTICALLY DETERMINED BY A GENETIC ALGORITHM THAT INCREASES DYNAMICALLY A SIZE OF THE ASSIGNED RANGE OF SAID EACH ONE SET OF WEIGHTS PROVIDED IN STEP (130).

FIG. 1E

200

SELECTING A BEST OF WEIGHTS FROM THE PLURALITY OF SETS OF WEIGHTS PROVIDED IN STEP (130), SAID BEST SET OF WEIGHTS BEING HEURISTICALLY DETERMINED BY A GENETIC ALGORITHM THAT ENABLES FINDING THE BEST SOLUTION THAT MAXIMIZES THE CORRELATION FACTOR R OF THE OVERALL OBJECTIVE IMAGE QUALITY F WITH THE SUBJECTIVE EVALUATION WITHOUT THE NEED TO CARRY OUT AN EXHAUSTIVE SEARCH TO FIND THE BEST SET OF WEIGHTS.

FIG. 1F

CALCULATING OF THE CORRELATION FACTOR R IN STEP (160) BY USING A SPEARMAN RANK ORDER COMPRISING THE FOLLOWING EQUATION:

$$R = 1 - \frac{6*(X-Y)^t (X-Y)}{k(k^2-1)} ,$$

WHEREIN X IS EQUAL TO A VECTOR OF RANKED k OBJECTIVE VALUES FOR THE k SEQUENCES (k*1), AND

Y IS EQUAL TO A VECTOR OF RANKED k SUBJECTIVE EVALUATION FOR THE k SEQUENCES (k*1).

FIG. 2

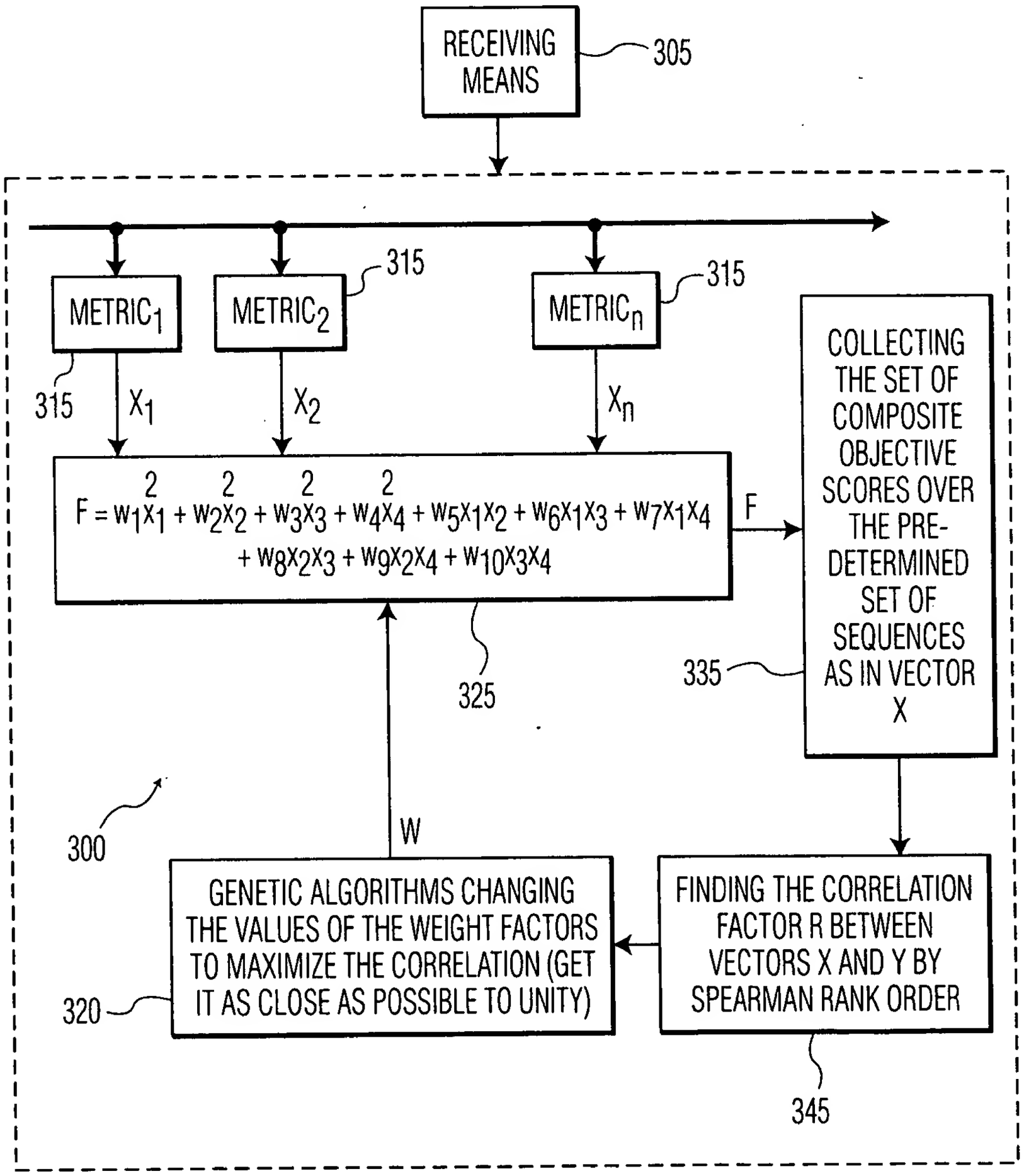
RECEIVING MEANS
305
METRIC1
METRIC2
METRICn
315
315
315
X1
X2
Xn
F = w1x1^2 + w2x2^2 + w3x3^2 + w4x4^2 + w5x1x2 + w6x1x3 + w7x1x4 + w8x2x3 + w9x2x4 + w10x3x4
F
325
COLLECTING THE SET OF COMPOSITE OBJECTIVE SCORES OVER THE PRE-DETERMINED SET OF SEQUENCES AS IN VECTOR X
335
300
W
GENETIC ALGORITHMS CHANGING THE VALUES OF THE WEIGHT FACTORS TO MAXIMIZE THE CORRELATION (GET IT AS CLOSE AS POSSIBLE TO UNITY)
320
FINDING THE CORRELATION FACTOR R BETWEEN VECTORS X AND Y BY SPEARMAN RANK ORDER
345

FIG. 3